

AD-A092 916

NAVAL AIR DEVELOPMENT CENTER WARMINSTER PA AIRCRAFT --ETC F/G 5/9
A COMPARATIVE EVALUATION OF TWO TYPES OF AVIATION MAINTENANCE D--ETC(I)
APR 80 T D HANNA
NADC-80071-60

UNCLASSIFIED

NL

JOE I
411
3-19-2

END
DATE
FILMED
DTIC

REPORT NO. NADC-80071-60

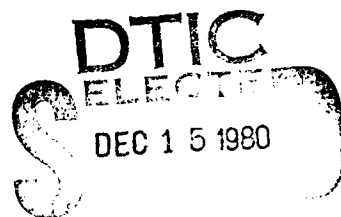


A COMPARATIVE EVALUATION OF TWO TYPES OF
AVIATION MAINTENANCE DOCUMENTS:
MAINTENANCE INSTRUCTION MANUALS AND THE "WORK PACKAGES"

Thomas D. Hanna, M.S.
Aircraft and Crew Systems Technology Directorate
NAVAL AIR DEVELOPMENT CENTER
Warminster, Pennsylvania 18974

2 APRIL 1980

FINAL REPORT
WORK REQUEST NO. N627677WR00180



Approved for Public Release; Distribution Unlimited

Prepared for
NAVAL AIR TECHNICAL SERVICES FACILITY
Department of the Navy
Philadelphia, PA 19111

80 12 12 016

AD A092916

DDC FILE COPY

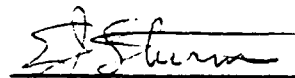
NOTICES

REPORT NUMBERING SYSTEM - The numbering of technical project reports issued by the Naval Air Development Center is arranged for specific identification purposes. Each number consists of the Center acronym, the calendar year in which the number was assigned, the sequence number of the report within the specific calendar year, and the official 2-digit correspondence code of the Command Office or the Functional Directorate responsible for the report. For example: Report No. NADC-78015-20 indicates the fifteenth Center report for the year 1978, and prepared by the Systems Directorate. The numerical codes are as follows:

CODE	OFFICE OR DIRECTORATE
00	Commander, Naval Air Development Center
01	Technical Director, Naval Air Development Center
02	Comptroller
10	Directorate Command Projects
20	Systems Directorate
30	Sensors & Avionics Technology Directorate
40	Communication & Navigation Technology Directorate
50	Software Computer Directorate
60	Aircraft & Crew Systems Technology Directorate
70	Planning Assessment Resources
80	Engineering Support Group

PRODUCT ENDORSEMENT - The discussion or instructions concerning commercial products herein do not constitute an endorsement by the Government nor do they convey or imply the license or right to use such products.

APPROVED BY:


E. J. STURM
CAPT, USN

DATE:

8 October 80

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NADC-80871-60	2. GOVT ACCESSION NO. AD-A092 916	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A COMPARATIVE EVALUATION OF TWO TYPES OF AVIATION MAINTENANCE DOCUMENTS: MAINTENANCE INSTRUCTION MANUALS AND THE WORK PACKAGES		5. TYPE OF REPORT & PERIOD COVERED FINAL rept.
7. AUTHOR(s) Thomas D. Hanna		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Aircraft & Crew Systems Technology Directorate 602 Naval Air Development Center Warminster, Pennsylvania 18974		8. CONTRACT OR GRANT NUMBER(s) Work Request N627677WR00180
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Air Technical Services Facility Department of the Navy Philadelphia, PA 19111		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 1035		12. REPORT DATE 2 APR 1980
		13. NUMBER OF PAGES
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Aircraft Maintenance Training Training Publications Work Package/Maintenance Navy Training		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) > The MIMs (Maintenance Instruction Manuals) for the APQ-126 Radar Set were rewritten in a style and format that requires less experience, skills, reading comprehension, and analytical abilities to effectively perform the maintenance on this system. All subjects were tested individually for approximately two hours with the main interview divided into five sections. Four of the sections consisted of instructions, demonstration problems, maintenance problems to be solved by the		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102- LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

373 532

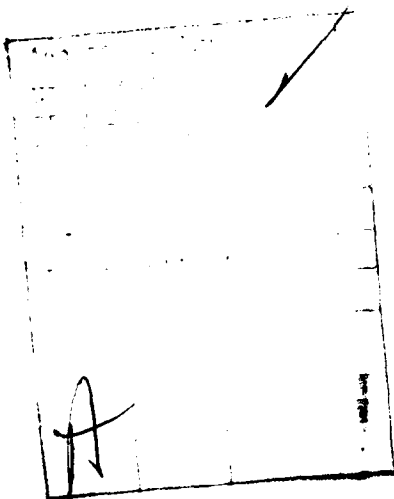
LB

subject using both MIMs and WPs, and questions or comments on which set of documents were easier to use and why, e.g., differences in ease of finding the required information, ease of using tables and figures, ease of reading instructions, use of schematics, wiring diagrams, component parts location, etc. A fifth section of the interview consisted of an overall summary evaluation of both sets of documents.

A description is given for each of the five sections of the interview which include External Access Tasks, Internal Access Tasks, Pictorial and Symbolic Reference Tasks (use of IPBs), Procedural Directions and Decision Making Tasks, and Overall Summary Evaluation. After each section the subject answered questions or commented on his evaluation of the two sets of manuals as being easier to locate the required information, to use in working the problems, to use when working in a shop, differences in how the two sets of manuals were written, and any other comments about the two sets of manuals or the evaluation questions.

The results indicate that all subjects preferred using the WPs over the MIMs for all categories of the interview. The data obtained for each section of the interview and their implications for the maintenance of airborne weapons systems in a controlled milieu are discussed in detail. The results strongly suggest using the WPs in lieu of the MIMs for classroom instruction in support of maintenance training on the APQ-126 Radar Set and that the WP concept merits further study for other airborne weapons systems evaluations.

Five appendices are attached to the report which contain (1) a background and rationale for the WP concept, (2) some of the differences between the MIMs and the WPs, (3) information on the subjects, (4) the packet given to each subject with the instructions, demonstration problems, maintenance problems for the subject to solve, and questions for the subject to answer after each section of the interview, and (5) major written comments elicited from the aviation maintenance technicians for each section of the interview.



S/N 0102- LF 014-6601

S U M M A R Y

In an effort to improve the quality of maintenance publications for airborne weapons systems, a program was initiated to rewrite the MIMs (Maintenance Instruction Manuals) for the APQ-126 Radar Set in a style and format that requires less experience, skills, reading comprehension, and analytical abilities to effectively perform the maintenance on this system.

The MIMs usually require the user to locate material on several pages within a volume and often on pages in different volumes. The table of contents in each volume of the MIMs only contains information for equipment repair instructions in that manual. Thus, a technician may have to look through all of the manuals to find the relevant text. Since the table of contents is divided into different sections for each subsystem, the technician must go to that particular section in the table of contents to find test or repair information as opposed to theory of operation sections or illustration sections.

An alternative documentation approach, called WPs (Work Packages), was written in a format that assembles all the necessary information for maintaining a subsystem or component into a single Work Package. Each volume has an alphabetical index which contains the specific number of the WP for locating information or maintenance actions for a module. The technician merely scans the alphabetical indices to find the relevant text. The indices of the WPs are short, alphabetical, and cross indexed, e.g., the required information may be located from the name of the unit/module/component or from the type maintenance action or information desired. All information concerning the module is contained in a few pages of one small WP.

An interview, designed to comparatively evaluate the MIMs and WP approaches, was divided into five sections. Four of the sections consisted of instructions, demonstration problems, maintenance problems to be solved by the subject using both the MIMs and WPs, and questions or comments on which set of documents were easier to use and why, e.g., differences in ease of finding the required information, ease of using tables and figures, ease of reading instructions, use of schematics, wiring diagrams, component parts location, etc. A fifth section of the interview consisted of an overall summary evaluation which was completed after all problems had been solved and the subject had a chance to relax and carefully consider his overall evaluation of both sets of documents.

A description is given for each of the five sections of the interview which included External Access Tasks, Internal Access Tasks, Pictorial and Symbolic Reference Tasks (use of IPBs), Procedural Directions and Decision Making Tasks, and Overall Summary Evaluation. After each section the subject answered questions or commented on his evaluation of the two sets of manuals as being easier to locate the required information, to use in working the problems, to use when working in a ship, differences in how the two sets of manuals were written, and any other comments about the two sets of manuals or the evaluation questions.

The results indicate that all subjects preferred using the WPs over the MIMs for all categories of the interview. The data obtained for each section of the interview and their implications for the maintenance of airborne weapons systems in a controlled milieu are discussed in detail. The results strongly suggest using the WPs in lieu of the MIMs for classroom instruction in support of maintenance training on the APQ-126 Radar Set and that the WP concept merits further study for other airborne weapons systems evaluations.

Five appendices are attached to the report. Appendix A contains a background and rationale for the WP concept. Appendix B indicates some of the differences between the MIMs and the WPs. Appendix C describes some of the characteristics of the subjects. Appendix D is the packet given to each subject which contains the instructions, demonstration problems, maintenance problems for the subject to solve, and questions for the subject to answer after each section of the interview. Appendix E consists of major written comments elicited from the aviation maintenance technicians for each section of the interview.

TABLE OF CONTENTS

	<u>PAGE</u>
SUMMARY	1
INTRODUCTION	4
METHODOLOGY	5
Subjects	5
Materials	5
Procedure	5
A. External Access Tasks	6
B. Internal Access Tasks	6
C. Pictorial and Symbolic Reference Tasks (Use of IPBs)	6
D. Procedural Directions and Decision Making Tasks	7
E. Overall Summary Evaluation	7
RESULTS	8
DISCUSSION	12
RECOMMENDED USE OF RESULTS	13
ACKNOWLEDGMENT	14

LIST OF TABLES

I. Comparison of Maintenance Instruction Manuals (MIMs) and Work Packages (WPs) by Nine Aviation Maintenance Technicians	9
II. Overall Evaluation of Maintenance Instruction Manuals (MIMs) and Work Package (WPs) by Nine Aviation Maintenance Technicians ...	10
III. Summary of the Thirteen Judgements Made by Each of the Nine Technicians	11

LIST OF APPENDICES

A. Background and Rationale for the WP Concept	A-1
B. Some Differences Between The MIMs and the WPs	B-1
C. Information on Subjects Participating in Evaluation of Two Sets of Maintenance Manuals	C-1
D. Packet Used by Each Subject Containing Instructions, Demonstration Problems, Problems for the Subjects to Solve, and Questions Covering Each Section of the Interview	D-1
E. Major Written Comments Elicited from Technicians for Each Section of the Interview	E-1

INTRODUCTION

Following system acquisition, a major expense of today's fleet is the cost of maintaining the airborne weapon systems and the required GSE (Ground Support Equipment), the logistics and control of inventories, maintenance training, and new maintenance instructions for modifications of airborne weapon systems.

A large part of the maintenance of these systems requires the use of documents in one form or another, e.g., MIMs (Maintenance Instruction Manuals), IPBs (Illustrated Parts Breakdowns), OCLs (Operator Check Lists), PIs (Programmed Instructions), JPAs (Job Performance Aids), JPTAs (Job Performance Training Aids), or NATOPS (Naval Air Training and Operating Procedures Standardization Manuals), etc. In a continuing effort to improve the quality of the various maintenance publications, a program was initiated to rewrite the MIMs for the APQ-126 Radar Set in a style and format that requires less experience and reading comprehension, and fewer skills and analytical abilities to effectively perform the maintenance on this system.

The MIMs, used extensively throughout the Navy for maintaining systems or equipments, usually consist of several volumes. The MIMs for the APQ-126 Radar Set consists of five volumes covering maintenance instructions and five volumes of IPBs. The information required for maintaining a given subsystem is arranged in a format that requires the user to locate material on several pages within a volume and often on pages in different volumes.

In an attempt to reduce the time and effort required to obtain maintenance or information, a new type of instruction manual, called WPs (Work Packages), was written in a format that assembles all the necessary information for maintaining a subsystem or component into a single, consolidated reference. The WPs for the APQ-126 Radar Set consist of five volumes, each containing approximately 30 WPs. Each volume has an alphabetical index that is cross referenced, e.g., the required information may be located from either the name of the component, the type of maintenance action required, or the type of technical information desired. Information on a particular component may be located by scanning the alphabetical indices for the name of that component. Once the name of that component is located, there are subheadings for Adjustment, Alignment, IPB, Principles of Operation, Repair, Testing, Troubleshooting, etc., along with the number of the specific WP which contains the desired information.

In addition, specific types of technical information (such as IPB, Repair, Testing, etc.) on a particular component or module (such as Amplifier Control, Digital-to-Analog Converter, Dither Programmer, etc.) may be located by looking under the technical information heading for the name of the module to find the correct WP number for that item. This cross reference format permits the subject to quickly locate a specific WP either by looking in the alphabetical index for the name of the unit/module/component or by looking for the specific type of information or maintenance action desired.

A short history, a description and a rationale for the WP concept is contained in appendix A. A chart listing some of the differences between the MIMs and the WPs is contained in appendix B.

M E T H O D O L O G Y

The comparative evaluation of the MIMs and the WPs employed only a limited amount of testing and a small number of subjects. All problems and questions presented to the subjects, however, were carefully selected to cover a representative sampling of both sets of manuals within a reasonable time frame. A typical interview required approximately two hours to complete. Nine subjects were used for the evaluation.

Subjects - Appendix C describes some of the characteristics of the nine subjects. The age, time in Navy, and time in rating/rank give an indication of the amount of experience the maintenance technician may have acquired, e.g., a neophyte fresh out of "A" school or a seasoned veteran with many years in the Navy.

Materials - The ten volumes of the MIMs and the five volumes of the WPs were available to the subject during the entire interview. Each subject was given a ten-page packet containing the instructions, maintenance problems to be solved by use of the MIMs and WPs, and comments to be made on which set of documents were easier to use and why, e.g., differences in ease of finding the required information, ease of using tables and figures, ease of reading instructions, use of schematics, wiring diagrams, component parts location, etc. This packet is enclosed as appendix D.

Procedure - All subjects had some experience in the use of MIMs, but none of the subjects had ever heard of a WP before the interview. It was recognized, therefore, that a natural bias toward the MIMs may exist due to the subject's familiarity and previous use of the MIMs. Consequently, it was important that the use of the WPs be explained in great detail before asking the subject to locate information or solve problems which illustrate various maintenance actions. Appendix B and the instructions on page 1 of appendix D indicate some of the differences between the WPs and MIMs.

The interview was administered to several training specialists within the Crew Systems Department prior to its presentation to the aviation maintenance technicians. The feedback and critical evaluation comments obtained from the trial runs and check out of the interview resulted in minor alterations and improvements in the wording and in some of the problems contained in the interview with the subjects.

At the beginning of each interview the instructions on page 1 of the packet (appendix D) were slowly read by the interviewer with the subject free to ask questions at any time. The instructions included a thorough explanation of the organization, general format, minor variations in nomenclature (see appendix B), and use of the WPs and MIMs.

Each subject was told that he was not being tested (to eliminate the suggestion of a threatening situation) but that he was merely comparing two different sets of manuals to determine which set was easier to use. By working problems using both sets of manuals, the subject became familiar with how they were arranged, the general format, and ease of finding the required information.

Following the initial instructions and explanation in the use of the WPs and MIMs, the main interview was divided into five sections. Four of the sections consisted of instructions, demonstration problems using both the MIMs and the WPs, problems for the subject to solve using both the MIMs and WPs, and questions for the subject to answer covering each section. A fifth section of the interview consisted of an overall summary evaluation in which the subject had to choose between the MIMs or the WPs as being easier to use on several items.

A brief description of the four task oriented sections and the summary section is as follows:

A. External Access Tasks

These tasks require the subject to locate information in the table of contents of the MIMs or in the indices of the WPs for theory or principles of operation, repair, testing, troubleshooting, set up to do performance tests, logic diagrams, etc., and the isolating of specific modules. Using the table of contents or indices, the subject was instructed to identify the page number in the MIMs or WPs that begins a section of repair, test, troubleshooting, or similar instructions for a piece of equipment.

After the problems in this section were completed, the subject answered questions designed to determine in which of the two sets of manuals was it easier to locate the required information, which type would be easier to use if working in a shop, and any comments about the two sets of manuals or the evaluation questions.

B. Internal Access Tasks

Starting at the beginning of a section on repair, testing, etc., of some item, the subject was asked to locate and identify the page number for associated relevant material. These tasks begin on a specific page covering the repairing, testing, troubleshooting, etc., of a module and the subject was required to identify the page numbers he would go to for associated graphics, component parts locations, schematics, alignment instructions, etc. These tasks simulate the on-the-job procedures of initially locating information to begin testing or repair of modules or units, and using associated test material during actual repair. After the problems in this section were completed, the subject answered questions similar to those appearing in the previous section of the interview.

C. Pictorial and Symbolic Reference Tasks (Use of IPBs)

The subject was asked to identify part numbers, nomenclature, SM and R Code numbers, and similar material by using the component parts location illustrations to identify information listed in the IPBs. These actions simulate the use of IPBs to order parts after isolating faults. The subject was also asked to use the IPBs to locate IPB tables for information in the MIMs and WPs. After locating the material the subject was asked to list the part numbers, nomenclature, reference designator, source code, units per assembly, quantities per article, next higher assembly for a component part, component of a major assembly, or similar information. After the problems in this section were completed, the subject answered questions similar to those appearing in the two previous sections of the interview.

D. Procedural Directions and Decision Making Tasks

The subject was given information on performing tests and checkout of equipment modules and then asked to make a decision by choosing the best answer from several choices on the next step to be performed. The information presented may indicate normal operation (continue the checkout), branching to an alignment or adjustment procedure, or replacement of a unit. The rationale for these procedures was to simulate normal repair of a part using the manual as a procedural guide, to follow directions, and as an aid in decision making. The subject was asked to use performance testing and troubleshooting tables in both MIMs and WPs. The tasks were specified and the subjects were directed to some section of test procedure where a decision is required. The subject was then asked to indicate which procedural option was the correct one to take according to his document (WP or MIM). After the problems in this section were completed, the subject answered questions similar to those appearing in the previous sections of the interview.

E. Overall Summary Evaluation

This section of the interview forced the subject to choose (1) MIM, (2) WP, or (3) ABOUT THE SAME for his overall evaluation of the two sets of manuals as being easier to locate the required information, to use in working the problems, and to use when working in a shop. In addition, the subject was asked if he noticed any differences in how the two sets of manuals were written and asked for any other comments about the two sets of manuals or the evaluation questions.

Written comments by the nine technicians for each section of the interview are contained in appendix E.

R E S U L T S

Table I indicates that the majority of the nine technicians preferred the use of the WPs over the MIMs for all questions in all sections of the interview. For example, five subjects preferred the WPs, two subjects preferred the MIMs, and two subjects had no preference for locating the required information under External Access Tasks. Similar comparisons may be made for each of the questions under External Access Tasks, Internal Access Tasks, Pictorial and Symbolic Reference Tasks, and Procedural Directions and Decision Making Tasks.

Table II presents an overall evaluation of the MIMs and WPs for each question of the four sections of the interview. Thus, eight subjects preferred the WPs and one subject preferred the MIMs for locating the required information. Similar comparisons may be observed for working the problems and using the manuals in a shop.

Table III displays the 13 judgments made by each of the nine technicians for all sections of the interview. Subjects 4, 7, and 9 each strongly preferred the WPs over the MIMs with all 13 judgments. Subject 2 preferred the WPs the least of the nine subjects but still preferred the WPs over the MIMs by a total of 6 to 3 of the judgments with four choices showing no preference.

Major written comments elicited from the interviewers for each section of the interview are contained in appendix E.

TABLE I - COMPARISON OF MAINTENANCE INSTRUCTION MANUALS (MIMs) AND
WORK PACKAGES (WPs) BY NINE AVIATION MAINTENANCE TECHNICIANS

Task	Number of Technicians		
	Preferring WP	Preferring MIM	With No Preference
<u>A. External Access Tasks</u>			
Locate required information	5	2	2
Working in a shop	8	0	1
<u>B. Internal Access Tasks</u>			
Locate required information	6	1	2
Working in a shop	8	0	1
<u>C. Pictorial and Symbolic Reference Tasks (Use of IPBs)</u>			
Locate required information	7	1	1
Working problems	6	0	3
Working in a shop	7	0	2
<u>D. Procedural Directions and Decision Making Tasks</u>			
Locate required information	8	0	1
Working problems	9	0	0
Working in a shop	9	0	0
<u>E. Overall Summary Evaluation</u>			
Overall, locate required information	8	1	0
Overall, working problems	9	0	0
Overall, using in the shop	<u>8</u>	<u>0</u>	<u>1</u>
Sum	98	5	14
Per Cent	84	4	12

TABLE II - OVERALL EVALUATION OF MAINTENANCE INSTRUCTION MANUALS (MIMs)
AND WORK PACKAGES (WPs) BY NINE AVIATION MAINTENANCE TECHNICIANS

Summary Evaluation	Number of Technicians		
	Preferring WP	Preferring MIM	With No Preference
Locate Required Information	8	1	0
Working Problems	9	0	0
Using in the Shop	8	0	1

TABLE III - SUMMARY OF THE THIRTEEN JUDGMENTS
MADE BY EACH OF THE NINE TECHNICIANS

Subject	Prefer WP	Prefer MIM	No Preference
1	10	1	2
2	6	3	4
3	10	0	3
4	13	0	0
5	10	0	3
6	12	0	1
7	13	0	0
8	11	1	1
9	<u>13</u>	<u>0</u>	<u>0</u>
Sum	98	5	14
Per Cent	84	4	12

DISCUSSION

It is clear that the nine aviation maintenance technicians participating in this study preferred using the WPs over the MIMs for all questions in all categories contained in the interview. Three of the nine subjects preferred the WPs over the MIMs in all 13 judgments. Those subjects who preferred the WPs the least still preferred the WPs over the MIMs by a ratio of better than 2 to 1 judgments. Major comments detailing the reasons for such preferences are contained in appendix E.

For the External Access Tasks, the subjects preferred the WPs over the MIMs by a total of 13 to 2 judgments. Some of the reasons for these scores may be observed from the comments in appendix E and from an examination of the organizational format and use of the two sets of documents as indicated in appendix B.

The table of contents in each volume of the MIMs only contains information for equipment repair instructions in that manual. Thus, if a subject was unfamiliar with the MIMs he must look through all of the manuals to find the relevant text. Moreover, because the table of contents is divided into different sections for each subsystem, the subject must go to that particular section in the table of contents to find test and repair information as opposed to theory of operation sections or illustrations sections.

Each volume of the WPs has a short alphabetical index which contains the specific number of the WP for locating information or maintenance actions for a module. If a subject was unfamiliar with the WPs, he merely scans the alphabetical indices of the five volumes to find the relevant text. The indices of the WPs are much shorter than the table of contents in the MIMs, are alphabetically arranged for both modules and maintenance information and are cross indexed. Moreover, all information concerning the module is contained in a few pages of one small WP.

For the Internal Access Tasks, the subjects preferred the WPs over the MIMs by a total of 14 to 1 judgments. In the MIMs, internal access is referenced by tables which may be many pages from the initial reference and can only be found by turning pages or returning to the appropriate section of the master index. In addition, the only way to locate theory of operation information, which may be useful in following through a schematic diagram, is to return to the theory of operation section of the master index to find the appropriate page references.

In the WPs, all the information is either indexed on the first page of the WP or in nearby pages with no intervening information about other parts or equipment items.

For the Pictorial and Symbolic Reference Tasks, which make use of the IPBs, the subjects preferred the WPs over the MIMs by a total of 20 to 1 judgments. To find associated IPB material in the MIMs, it is necessary to go through the IPB index (a separate volume) to obtain a figure and index number which then identifies the volume and index number for the associated IPB. The subject will then need to find that page of that figure and index number and record it. The WPs have associated IPBs adjacent to the illustrations. They are also indexed at the front of each WP by page number. In addition, information such as the

SM and R Code in the MIMs is in the index, by part number, not IPB table. In the WPs all the information is on the same page.

For the Procedural Directions and Decision Making Tasks, the subjects preferred the WPs over the MIMs by a total of 26 to 0 judgments. In the MIMs, the tables for Minimum Performance Testing and for Troubleshooting of units and modules are separate. If in testing a unit or a module, using the Minimum Performance Test table, an indication of a malfunction is encountered, it is necessary to go to the associated Troubleshooting table which is keyed to the Minimum Performance Test table, enter the Troubleshooting table at the appropriate place, isolate and repair the malfunction and return to the Minimum Performance Test table to complete the checkout. In the WPs the two tables are combined and sequential procedures are clearly indicated. The integration of the two tables into one extended table results in easier performance with less searching back and forth between tables.

For the Overall Summary Evaluation, the subjects preferred the WPs over the MIMs by a total of 25 to 1 judgments. This section of the interview was completed after all problems had been solved for the entire interview and the subject had a chance to relax and carefully consider his overall evaluation of both sets of documents.

RECOMMENDED USE OF RESULTS

The results obtained in this comparative evaluation strongly favor the use of WPs over the MIMs for classroom instruction in support of maintenance training on the APQ-126 Radar Set. Although the evaluation employed only a limited amount of testing, a relatively small number of subjects, and covered only one airborne weapon system, the results indicate that the WP concept merits further study.

A C K N O W L E D G M E N T

The author wishes to express his gratitude to the officers and men attached to the Aircraft Intermediate Maintenance Department and the Reserve Anti Submarine Warfare Tactical School, NAS Willow Grove, whose cooperation, diligence, and participation led to the successful conduct of this study. The author also appreciates the helpful suggestions during the early stages of this study from Ms. Jane Campbell, Ms. Phillis York, and Ms. Joann Wright who were previously assigned to the program before accepting positions outside of the Crew Systems Department, Naval Air Development Center.

APPENDIX A

BACKGROUND AND RATIONALE FOR THE WP CONCEPT

The Simplified Maintenance Manual Design (SMMD) plan was introduced in 1969 and represented the first R&D effort to test the Work Package (WP) concept. The WP format consists of placing all information for one operation into a single package and improving the layout of graphics, simplicity of presentation, and ready access of information. This specific application utilized intermediate level maintenance of the APQ-126 Radar System to evaluate the WP concept. The manuals were developed as a result of the microfilm conversion of all manuals and written according to Work Package Specifications MIL-M-81927, MIL-M-81928, MIL-M-81929, and a recently developed Writer's Style Guide (Management Procedures Handbook NAVAIR 00-25-700).

Since many maintenance documents were tested and found to have a Reading Grade Level of 13+, the goals of the WP program were to reduce the complexity of verbal and nonverbal information, improve the organization of the manuals, and insure the completeness and accuracy of all information.

The background of the SMMD program included (1) the development of specifications and a Writer's Style Guide to standardize the interpretation of the specifications, (2) the selection of a test bed for trial studies, the APQ-126 Radar Set being chosen because hard copy MIMs were available for comparison, (3) writing the WP manuals, and (4) a three phase evaluation. The evaluation consisted of (a) operationally satisfying the goals of readability, comprehension, accuracy, etc., by demonstrating that there were measurable differences between the MIMs and WPs in sentence length, difficulty of words, etc., (b) determine these differences precisely by preparing Controlled Performance Tests to evaluate the usability of the WPs (acceptability, reading efficiency, comprehension) to perform simulated maintenance actions. These task-oriented-tests employed a paper and pencil evaluation of job sample tests requiring the use of written job aids to determine ease of working with manuals in a classroom environment, (c) determine whether the manuals improve job performance for maintenance of the APQ-126 in the field. Phase (b), described above, is the topic of this report.

The present evaluation study was designed as an intermediary step in the Navy testing program of the WPs to maximize the use of manuals. It required the reading and use of manuals as the main element of the task performed as opposed to maintenance actions in the field. The evaluation was an attempt to control the reading aspect of task performance and determine whether the WP manuals, as used in a classroom environment, would effectively support maintenance of the APQ-126 system.

A P P E N D I X B

SOME DIFFERENCES BETWEEN THE MIMs AND THE WPs

	<u>MIMs</u>	<u>WPs</u>
1. Number of Volumes	10	5
2. Total Number of Pages	Approximately 2450 with text on both sides of page	Approximately 2490 with text often on one side of page
3. Letter Size	Relatively small. Print more difficult to read.	Relatively large. Print much easier to read.
4. Fold Outs	Many	None
5. Words	Relatively difficult	Shorter, more common, relatively easy
6. Sentences	Relatively long and more difficult to understand	More easily understood and shorter
7. Time Required to Explain Use	Much time is required	Relatively little time. More self-explanatory
8. Clarity	Less concise with much extraneous information. Writing more difficult to follow. Information scattered and more difficult to locate.	Information more concise and to the point. Writing much easier to follow. All required information in one section.
9. Maintenance Information/Actions	Required information may be in several sections or volumes.	All required information in one WP.
10. Index (Table of Contents)	Very long, not alphabetical, not cross indexed. Arranged by Tables, Illustrations, Theory of Operations, and Maintenance Actions for modules/components/units. More difficult to use and requires more time.	Short, alphabetical, cross indexed. Arranged for maintenance information/actions and by modules/components/units. Easier and quicker to use.
11. Familiarity	Most technicians have previously used	Totally unfamiliar
12. Differences in Nomenclature:	Theory of Operation Preliminary Procedures Before Testing Quantities Per Article (for PNs) Minimum Performance Testing Schematic Diagram	Principles of Operation Pre Test Set Up; Initial Test Set Up Units Per Assembly (for PNs) Set Up to do Performance Tests Schematic Diagram (sometimes Block Diagram)

NADC-80071-60

SOME DIFFERENCES BETWEEN THE MIMS AND THE WPs (CONT.)

	<u>MIMS</u>	<u>WPs</u>
13. Organization	Not organized too well and required information difficult to locate.	Information more logically arranged and easy to locate.
14. Time Required to Locate Information	Requires much more searching, is more difficult to use, and more time consuming.	Better arrangement, easier to use and find information quickly.
15. Ease of Using Required Information	Frequently need to turn pages back and forth. Information too widely dispersed. Without intimate knowledge of system must search virtually everything.	All required information in a single small WP. Information arranged more conveniently and easier to locate.
16. Test and Trouble-shoot Tables	Information in two different tables.	All information in one table.
17. IPB	PNs listed in chronological order	No numerical index for PNs

A P P E N D I X C

INFORMATION ON SUBJECTS PARTICIPATING IN
EVALUATION OF TWO SETS OF MAINTENANCE MANUALS

Subjects	Age	Rating/Rank	Location*	Time in Navy (Yrs & Mo)	Time in Present Rating (Yrs & Months)
1	25	AT-2	CSD	7-7	5-6
2	31	AT-1	CSD	12-2	2-1
3	32	AE-1	WG	14-4	1-2
4	32	AT-1	WG	14-4	4-0
5	29	AE-2	WG	11-3	6-6
6	32	CIV**	WG	14-0***	9-0****
7	34	CIV**	WG	3-0***	3-0****
8	30	AX-1	WG	7-4	0-6
9	28	AT-2	WG	6-0	1-0

* CSD - Crew Systems Department, Naval Air Development Center, Warminster, PA
WG - Naval Air Station, Willow Grove

** Civilian Aviation Maintenance Technician assigned to NAS Willow Grove

*** Total years and months of civilian experience in aviation maintenance

**** Total years and months in present civilian grade

A P P E N D I X D

Name _____ Age _____ Rating/Rank _____ Date _____

Years and Months in Navy _____ Years and Months in Present Rating _____

Instructions

We are going to compare two different series of publications covering intermediate level maintenance of the APQ-126 (V) Radar Set.

One series consists of conventional Maintenance Instruction Manuals for the APQ-126(V). There are five volumes of the maintenance instructions and five volumes of the Illustrated Parts Breakdown for this system (Point to them).

The second series, referred to as Work Packages, consists of five volumes, each with an index at the beginning of the volume (Point to them). For example, suppose you want to find information on the Antenna Scan Power Supply. By looking at the titles of the indices you will find the Antenna Scan Power Supply in the title of Volume 1-1. In the index of Volume 1-1, which is arranged alphabetically, you will find the Antenna Scan Power Supply on Page 1 with subheadings for Adjustment, Alignment, IPB, Principles of Operation, Repair, Testing, Troubleshooting, etc., along with the number of the specific Work Package which contains the desired information, i.e., Work Package 00600, 00700, 00800, 00900, etc.

In addition, you can look in Index 1-1 for specific information on the Antenna Scan Power Supply. For example, find IPB, Principles of Operation, Repair, Testing, or Troubleshooting, etc. Under each of these headings you will find the Antenna Scan Power Supply along with the Work Package number for that item. (Show each of these procedures in detail).

We will work several problems which illustrate various intermediate level maintenance actions or information required for maintenance of the APQ-126 (V). I am not testing you. We are merely comparing two different series of publications to determine which set is easier to use. By working problems using both sets, you will become familiar with how they are arranged, the general format, and ease of finding the required information.

I will work the example(s) given, first by using the conventional MIMs, and then by using the Work Packages. Then you will be asked to find the answers to problems similar to the example(s) I worked, first by using the MIMs and then by using the Work Packages.

I will then ask you for your comments on which set of documents you feel are easier to use and why, i.e., differences in ease of finding the required information, ease of using tables and figures, ease of reading instructions, use of schematics, wiring diagrams, component parts location, etc.

Any questions? If you are ready, let us begin with number 1.

A. The following modules need to be repaired. Using the index of the manuals, on what page would you find the following information?

<u>Information Needed</u>	<u>Module</u>	<u>Page</u>	
		<u>MIM</u>	<u>WP</u>
1. Theory of Operation	Rectifier Filter	_____	_____

For MIM, look in the Table of Contents to find where the information on theory of operation about the Rectifier Filter is given. Correct answer is page 4-1. (Merely see Theory of Operation in the Table of Contents and turn to page 4-1 to verify).

For WP, scan the index, which is in alphabetical order, to find where the information on theory of operation about the Rectifier Filter is given. In index 1-1 under Principles of Operation you will find the Rectifier Filter. Correct answer is Index 1-1, Work Package 01000, page 1. (Show above steps to interviewee).

Additional information on the Rectifier Filter is also listed under Testing, under IPB, under Troubleshooting, and is listed separately under Rectifier Filter. (Show each of these ways to the interviewee).

2. Troubleshooting Procedure Table	Command Generator	_____	_____
------------------------------------	-------------------	-------	-------

For MIM, look in the List of Tables for Command Generator, Troubleshooting Procedure. Correct answer is page 10-21. Turn to this page to verify.

For WP, read the titles of the Indices to find which one covers the Command Generator. It is not listed in the titles. So scan each index, which is in alphabetical order, for the Command Generator. It is listed under Index 1-3. Alphabetically, look in index 1-3 under troubleshooting to find the Command Generator as Work Package 00800. Looking through 00800, the Troubleshooting Procedure Table is found on page 7. Correct answer is 1-3, 00800, p 7. (Show above steps to interviewee).

Any questions? Now, you try to do the following:

3. Setup to do performance tests	Hyperbolic Function Generator (6A2)	_____	_____
4. Theory of Operation (for MIM) Principles of Operation (for WP)	Vertical Sweep Predriver (8A1)	_____	_____
5. Logic Diagram (MIM) Block Diagram (WP)	Controller (6A20)	_____	_____
6. Initial Test Setup	Multiple Air Navigation Indicator	_____	_____

Questions

1. Which of the two sets of manuals did you find easier to locate the required information? The MIM was (easier, about the same, more difficult) than the WP to locate the required information. (circle one).

2. Which of the two sets of manuals do you think would be easier to use if you were working in a shop? The MIM would be (easier, about the same, more difficult) than the WP to use in the shop. (circle one). Try to explain why.

3. Do you have any comments about the two sets of manuals or the evaluation questions?

B. Perform the following:

For MIM, turn to Volume II, page 8-14. This page contains the instructions for minimum performance testing of the Thyatron Trigger (2A7). What is the first page number for locating the information listed below?

For WP, turn to Volume 1-2, Work Package 01700, page 2 which contains the check-out and troubleshooting of the Thyatron Trigger (2A7). What is the first page number for locating the information below:

<u>Thyatron Trigger (2A7)</u>	<u>Page</u>	
	<u>MIM</u>	<u>WP</u>
Example (Show how to do for each set of manuals):		
1. Preliminary procedures before testing (MIM) Pre Test Setup (WP)	_____	_____
Any questions? Now, you try to do the following:		
2. Schematic Diagram	_____	_____
3. Component Parts Location Diagram	_____	_____

Questions

1. Which of the two sets of manuals did you find easier to locate the required information? The MIM was (easier, about the same, more difficult) than the WP to locate the required information. (circle one).

2. Which of the two sets of manuals do you think would be easier to use if you were working in a shop? The MIM would be (easier, about the same, more difficult) than the WP to use in the shop. (circle one). Try to explain why.

3. Do you have any comments about the two sets of manuals or the evaluation questions?

C. Perform the following:

For MIM, the location of the IPB lists for the Stabilization Control (1A2) is contained in Volume I of the IPB (Index). Use these IPB lists to answer the following:

1. What is the Figure and Index Number for Part Number 737212-1? _____
2. What is the Part Number for the cover of 1A2? _____
3. How many quantities per article for the Relay Assembly?
(Part Number 737212-1)? _____

For WP, the location of the IPB information for the Stabilization Control (1A2) is contained in Volume 1-1. Use the IPB information to answer the following:

1. What is the Part Number for the cover of 1A2? _____
2. What is the SM and R Code for Part Number 605217-4? _____
3. How many units per assembly for the Relay Assembly,
Stabilization Control (Part Number 737212-1)? _____

1. Which of the two sets of manuals did you find easier to locate the required information? The MIM was (easier, about the same, more difficult) than the WP to locate the required information. (circle one). Try to explain.

2. Which of the two sets of manuals was easier to use in working the problems? The MIM was (easier, about the same, more difficult) than the WP for working the problems. (circle one). Try to explain.

3. Which of the two sets of manuals do you think would be easier to use if you were working in a shop? The MIM would be (easier, about the same, more difficult) than the WP to use in the shop. (circle one). Try to explain why.

4. Do you have any comments about the two sets of manuals or the evaluation questions?

D. Perform the following:

For MIM, turn to Volume II, page 7-99. This page contains instructions for minimum performance testing of the Amplifier Control (1A11A8). Assume you have completed tests 1 through 4, and at test 5 the DVM reading is 0.397 VAC. What is the next step? (circle correct number).

1. Adjust R 21 for 1.03 (± 0.01) v p-p.
2. Check amplifier stage at AR2.
3. Replace R 21.
4. Check for 400-Hz signal at Z2 pin 11.

For WP, turn to Work Package 1-1, 01500, page 2. This package contains instructions for testing the 668486-2-3 positive 200 VDC power supply (1A5). Assume you have completed test 1 with all indications normal. At test 2 you find capacitor A2C5 bad and replace it. What is the next step? (circle correct number).

1. Check diodes A1CR1, A1CR2, A1CR3, A1CR4, A1CR5, A1CR6.
2. Check that DVM indicates less than 0.05 VAC.
3. Set FUNCTION Switch on DVM to DC.
4. Wait 10 seconds and check again.

Questions

1. Which of the two sets of manuals did you find easier to locate the required information? The MIM was (easier, about the same, more difficult) than the WP to locate the required information. (circle one). Try to explain why.

2. Which of the two sets of manuals was easier to use in working the problems? The MIM was (easier, about the same, more difficult) than the WP for working the problems. (circle one). Try to explain why.

3. Which of the two sets of manuals do you think would be easier to use if you were working in a shop? The MIM would be (easier, about the same, more difficult) than the WP to use in the shop. (circle one). Try to explain.

4. Do you have any comments about the two sets of manuals or the evaluation questions?

Summary

1. Overall, which of the two sets of manuals did you find easier to locate the required information? MIM WP Same (circle one)

2. Overall, which of the two sets of manuals was easier to use in working the problems? MIM WP Same (circle one)

3. Overall, which of the two sets of manuals do you think would be easier to use if you were working in a shop? MIM WP Same (circle one)

4. Overall, did you notice any differences in how the two sets of manuals were written? Explain briefly.

5. Do you have any comments about the two sets of manuals or the evaluation questions?

A P P E N D I X E

MAJOR WRITTEN COMMENTS ELICITED FROM
TECHNICIANS FOR EACH SECTION OF THE INTERVIEW

A. External Access Tasks

Comments from subjects who preferred the WPs were numerous, such as: The WPs are faster and easier to use. The WPs are more concise and to the point. The WPs are easier to use and give a better understanding of the system because of the index arrangement. A publication containing IPB, Testing, Principles of Operation and similar material all in one volume is much preferred. The information in the MIMs is scattered in different sections and volumes so I would rather use the WPs. It is convenient to have Principles of Operation close at hand for troubleshooting as in the WPs. Having all the information together as in the WPs reduces the need to go from one book to another. It is difficult in the MIM when two sources of information are 50 to 100 pages apart. The MIMs are difficult to use because the material is not listed alphabetically as it is in the WPs. The WPs are easier to use because of the alphabetical arrangement. The MIMs use a hit and miss technique while with the WPs one can find the required information in half the time.

Comments from those preferring the MIMs were: The terms are different in the WPs. I am more familiar with the MIMs so it is easier but with a little time the WPs would become very easy to use.

B. Internal Access Tasks

Comments from subjects that chose the WPs included: All the required information is in one WP and eliminates looking through a large index as in the MIMs. Once you find the WP, all information is easily available. The WPs have a shorter index which is easier to use. The WPs would be a valuable asset to the IMA since they save time and are easier to use. In the MIM, each piece of information is listed separately but in the WP it is easier to find when all information is together. The WP is convenient, faster, and better than the MIM. The WP is small so you can find information quickly while the MIM requires much more searching and a scan of the entire section to determine the information needed. The WP is easier to use since the information is concise and accurate. With the WPs, there is no need to turn back and forth as in the MIMs. Information in the WPs is more logically arranged.

Comments from those preferring the MIMs were: For the MIMs, the page number is listed but for the WPs, the index gives the WP number which must be located and then the correct page number found. I like the two sets of documents about the same because I am more familiar with the MIMs.

C. Pictorial and Symbolic Reference Tasks (Use of IPB)

Comments from subjects who favored the WPs were: The WPs are good because once you have the WP number all information is easy to find. The print is much larger in the WPs and all information is in one manual. The WPs are better since it is much easier to get all information from one manual versus several different ones. The MIMs use several different pages in different parts of the

book while the WPs contain all information in one small booklet. The WPs are faster and too much time is wasted digging out necessary information from the MIMs. The WP items are easier to locate and the WP has more information in one location. You are not jumping around in the WPs as in different volumes of the IPB of the MIMs.

Comments from those preferring the MIMs were: If the WPs had a section for listing part numbers by order as the IPB of the MIMs, the WPs would be much easier to use. The MIMs have a numerical listing for both part number and unit or module number which the WPs do not. The MIMs are easier for part numbers, the WPs easier for other information. I like about the same because the WPs need a numerical index of parts for the IPB.

D. Procedural Directions and Decision Making

Comments from subjects who favored the WPs included: You are jumping around in the MIMs much more than in the WPs. The WP has more detailed instructions and all the needed information is in one packet which is easy to find. In the WPs, the whole test and troubleshoot is in one table but in the MIMs you must go back and forth in two tables. In the MIMs, you have to look for a different table to determine the steps when an indication was incorrect but in the WPs, the information is logically arranged so you can find the required data. The WPs are much easier to use since one book contains all the information required. Very little time is needed to explain how to use the WPs. The MIMs are more difficult to use due to the arrangement of the table of contents. The WP has a smaller area to cover and it is easier and faster to find the information. The MIMs require switching from page to page and searching the table of contents to find the correct table necessary to troubleshoot while the WP has all the necessary information on the same page. The ease of using the WPs shows definite advantages over the MIMs. The MIMs are bulkier and the information is too widely dispersed. More information is in one location in the WPs and you seldom need to turn pages. The information is more precise for a step-by-step method in the WPs. The print is much easier to read in the WPs.

There were no favorable comments on the MIMs for this section of the interview.

E. Overall Summary Evaluation

Overall summary comments from subjects who favored using the WPs were: The writing in the WPs was much easier to follow and the indexing system is a vast improvement over the MIMs. The WPs are a much better system to use where everything is condensed. The WPs have much larger print and a very good index in alphabetical order. The WPs are much faster to use compared to the MIMs which take twice as long and require a long memory. In the WPs, all information is readily accessible and easy to find but in the MIMs, anyone without an intimate knowledge of the system must search virtually everything. The WPs are more self-explanatory than the MIMs. The major differences were indexing with the WPs easier to locate information which was more complete. I would welcome a change from MIMs to WPs since work output could be increased by decreasing the time necessary to find information in the books. The WPs are better because they are arranged more conveniently and once you have the needed packet all information is easy to locate.

NADC-80071-60

Comments from those preferring the MIMs were: The WPs still need to be proved in the shop environment. One subject rated the WPs for using in the shop "about the same" because all of his experience has been with MIMs and he therefore is more familiar with them.